CYPERUS SANGUINOLENTUS (CYPERACEAE) NEW TO THE SOUTHEASTERN UNITED STATES, AND ITS RELATION TO THE SUPPOSED ENDEMIC *CYPERUS LOUISIANENSIS*

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ABSTRACT

Field studies show *Cyperus louisianensis* is locally common and weedy in eastern Louisiana and southern Mississippi and extend its range into Alabama and Georgia. Morphometric and herbarium studies show *C. sanguinolentus* and *C. louisianensis* are taxonomically indistinguishable, and *C. louisianensis* is treated as a synonym of *C. sanguinolentus*. The widespread weed, *C. sanguinolentus*, formerly thought to be restricted to the Eastern Hemisphere, is reported new to North America, and data on its frequency, distribution, and ecology in the southeastern United States are presented.

RESUMEN

Los estudios de campo muestran que *Cyperus louisianensis* es localmente común y una mala hierba en el este de Louisiana y el sur de Mississippi y que se extiende hasta Alabama y Georgia. Estudios morfométricos y de herbario muestran que *C. sanguinolentus* y *C. louisianensis* son taxonómicamente indistinguibles, y *C. louisianensis* se trata como un sinónimo de *C. sanguinolentus*. La mala hierba extendida, *C. sanguinolentus*, que previamente se creyó restringida al hemisferio este, se cita aquí como nueva para Norte América, y se presentan datos de su frecuencia, distribución y ecología en el sureste de los Estados.

INTRODUCTION

Cyperus sanguinolentus Vahl is widely distributed in the Eastern Hemisphere, where it has been cited as a weed (Holm et al. 1991; Mingyuan & Dehu 1970; Reed 1977; Kühn 1982). It is known from northeastern Africa, the Middle East, India, Sri Lanka, central Asia, southeastern Asia, China, Taiwan, Japan, Korea, the Philippines, Indonesia, Malaysia, and Australia (Clarke 1894; Holm et al. 1991; Kükenthal 1935–1936; Ohwi 1965; Mingyuan & Dehu 1970; Kern 1974; Reed 1977; Kühn 1982; Haines & Lye 1983; Wilson 1993) but has not been previously reported from the Western Hemisphere.

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Cyperus sanguinolentus is highly variable. Kükenthal (1935–1936) segregated five varieties and named seven forms, including six under the typical variety. Kükenthal's (1935–1936) infraspecific taxonomy of *C. sanguinolentus* is difficult to use, since he provided neither keys nor parallel descriptions of the taxa. Kern (1974) treated four subspecies, including the typical one, for Malaysia, and others (e.g., Ohwi 1965; Haines & Lye 1977) have treated additional infraspecific taxa. Table 1 compares infraspecific taxonomies of Kükenthal (1935–1936) and Kern (1974). Further research on this widespread and variable species throughout its range is needed for a more complete understanding of its infraspecific variation; however, such is beyond the scope of our study to determine the range, distribution, taxonomic relationships, and status of *C. sanguinolentus* in North America.

Its bifid style and lenticular achene with achene angle adjacent to rachilla clearly place *C. sanguinolentus* into subgenus *Pycreus*. Clarke (1894, 1908) segregated *Pycreus* as a genus and treated the taxon as *Pycreus sanguinolentus* Nees in subgenus *Reticulatae* section *Vestitae*. Kükenthal (1935–1936) adopted a broader definition of *Cyperus*, incorporating this taxon into subgenus *Pycreus* section *Sulcati* of that genus. The floral scales of *C. sanguinolentus* are distinctive, being characterized by lateral grooves (or *sulci)* typical of section *Sulcati* and, as its specific epithet implies, blood-red floral scale pigmentation. Although some recent authors (e.g., Koyama 1985; Goetghebeur 1986, 1989; Adams 1994; Bruhl 1995) fragment *Cyperus* and segregate *Pycreus* at the rank of genus, we have followed the more conservative generic taxonomy of Kükenthal (1935–1936) and Corcoran (1941), which, with some modification, is still widely used (e.g., Kern 1974; Haines & Lye 1977; Tucker 1983, 1987, 1994).

In 1977, Thieret described a new species, *C. louisianensis*, from specimens he collected at two close sites in Tangipahoa Parish, Louisiana. Thieret (1977) placed *C. louisianensis* in subgenus *Pycreus*, noted its similarity with *C. sanguinolentus*, and provided several contrasting characteristics separating it from *C. sanguinolentus* (Table 2) and a dichotomous key distinguishing it from related North American species in subgenus *Pycreus*. *Cyperus louisianensis* was listed by the Department of Interior, United States Fish & Wildlife Service, in *category two* among endangered or threatened species (Anonymous 1993). Until Bryson and Carter (1994) showed it was widespread and weedy in southern Mississippi, *C. louisianensis* was thought to be a narrow endemic restricted to two sites in southeastern Louisiana.

In 1993, the first author was contracted by the United States Fish & Wildlife Service to prepare a status survey on *C. louisianensis*, which provided the initial financial support for this study. The major objectives of the survey were to seek additional populations of *C. louisianensis* and additional collections in herbaria, to review its status as a potentially rare plant, and to examine its taxonomic relationship with the Old World weed *C. sanguinolentus*. In this report, we provide a complete record of our field and herbarium investigations into the distribution, ecology and taxonomic relationships of *C. louisianensis* with *C. sanguinolentus*.

TABLE 1. Infraspecific taxonomy of *Cyperus sanguinolentus*.

Kükenthal (1935–1936) - worldwide treatment	**Kern (1974) - *Flora Malesiana***
C. sanguinolentus Vahl	*C. sanguinolentus* Vahl
var. *sanguinolentus*	ssp. *sanguinolentus*
f. *rubro-marginatus* (Schrenk) Kük.	not treated
f. *neurotropis* (Steud.) Kük.	not treated
f. *flaccidulus* (Boeck.) Kük.	not treated
f. *cyrtostachys* (Miq.) Kük.	ssp. *cyrtostachys* (Miq.) Kern
f. *melanocephalus* (Miq.) Kük.	ssp. *melanocephalus* (Miq) Kern
f. *humilis* Kuk.	[=ssp. *melanocephalus*]
var. *micronux* (C.B. Clarke) Kük.	not treated
var. *teysmannii* (Boeck.) Kük.	ssp. *teysmannii* (Boeck.) Kern
var. *korshinskii* (Meinsh.) Kük.	not treated
var. *pratorum* (Korotky) Kük.	not treated
var. *areolatus* (R. Br.) Kük.	not treated
f. *setaceus* Kük.	not treated

TABLE 2. Comparison of *Cyperus louisianensis* and *C. sanguinolentus* (fide Thieret 1977).

C. louisianensis	***C. sanguinolentus***
Achenes elliptic to elliptic-obovate	Achenes orbicular-obovate
Achenes rather flattened (thickness-length ratio: 0.25–0.30)	Achenes turgid (thickness-length ratio: 0.40)
Floral scales well imbricated and flat along the margin	Floral scales often barely imbricate, at least proximally, permitting some see through; frequently involute along the margin

MATERIALS AND METHODS

Field studies.—Systematic intensive field surveys for *C. louisianensis* populations in southeastern Louisiana and southern Mississippi were made by the authors during the periods 15–21 September 1993 and 14–18 October 1993. Subsequently, the authors have continued to search sporadically for this taxon when time and circumstances have allowed. Thieret's (1977) published account and more recent collections from the type locality with additional documentation, kindly provided by Nelwyn Gilmore, Louisiana Natural Heritage Program, were used to relocate the holotype locality in Tangipahoa Parish, Louisiana. Attempts to re-locate Thieret's paratype locality were unsuccessful, which is not surprising since habitat in the vicinity of this site was substantially altered by highway and commercial construction activities. Observations at the holotype locality showed the species to be locally abundant along the margin of a shallow artificial pond and nearby ditches in the flatwoods, habitat greatly altered by humans. Searches of potential

habitat began outward from the holotype locality. Habitat descriptions, estimates of population size, and voucher specimens were made when populations were found.

Greenhouse studies.—Transplants and plants of *C. louisianensis* started from seeds were maintained under controlled conditions in a greenhouse at the United States Department of Agriculture, Agricultural Research Service, Jamie Whitten Delta States Research Center, at Stoneville, Mississippi. Observations on these plants by the second author were made in order to understand better the life history and phenology of *C. louisianensis*, especially to determine whether it is annual or perennial.

In greenhouse experiments, seeds of *C. louisianensis* were sewn in flats on top of a 6 cm-deep mixture of a Bosket silt loam soil (Mollic Hapludaf) and sphagnum (50% v/v) in the first week of March, June, September, and December in 1994, 1995, and 1996. Trays were watered from beneath to prevent seed and soil disturbance. Individual *C. louisianensis* seedlings (> 5 cm tall) were transplanted into 15 cm-diameter pots and watered from beneath. The greenhouse was maintained at 30 to 35° C day and 25 to 30° C night, at 60 to 75% relative humidity, and without supplemental lighting. In 1994 and 1995, flowering and fruiting plants of *C. louisianensis* were transplanted from several sites in Hancock County, Mississippi, and St. Tammany Parish, Louisiana, into 15 cm-diameter pots and maintained under the same greenhouse conditions as plants grown from seeds. Data were taken on date of seedling emergence, date of flowering and fruiting, and plant longevity.

Herbarium and morphometric studies.—Specimens of *C. louisianensis* and *C. sanguinolentus* were borrowed from selected herbaria (BRIT, GH, MO, NY and US) in order to examine the variation in *C. louisianensis* and its taxonomic relationship with *C. sanguinolentus*. Quantitative data on the achene characteristics used by Thieret (1977) to distinguish *C. louisianensis* from *C. sanguinolentus* were taken from these specimens and from our own collections. Five achenes from each of 13 specimens of *C. louisianensis* and 20 specimens of *C. sanguinolentus* were examined. A Bausch & Lomb stereozoom (6X–30X) dissecting microscope with ocular micrometer was used to measure various achene dimensions (Table 3, Fig. 1), and ratios (Table 3) derived from these measurements were used to analyze differences in the plane shapes of achenes used by Thieret (Table 2) to distinguish *C. louisianensis* and *C. sanguinolentus*. Minitab release 11.21 (Anonymous 1996) was used to analyze these data statistically and to construct scatter diagrams for comparing variation in *C. louisianensis* and *C. sanguinolentus*. Representative spikelets from selected specimens were photographed using an Olympus™ SZ40 stereozoom dissecting microscope equipped with a Kodak™ DC120 zoom digital camera. Our more numerous recent collections were used with Thieret's (1977) original description and type materials to prepare a revised description and an illustration.

RESULTS

Distribution and ecology of *Cyperus louisianensis*.—Since 1993, our field surveys have revealed numerous populations (>40) of *C. louisianensis* in southeastern Louisiana and

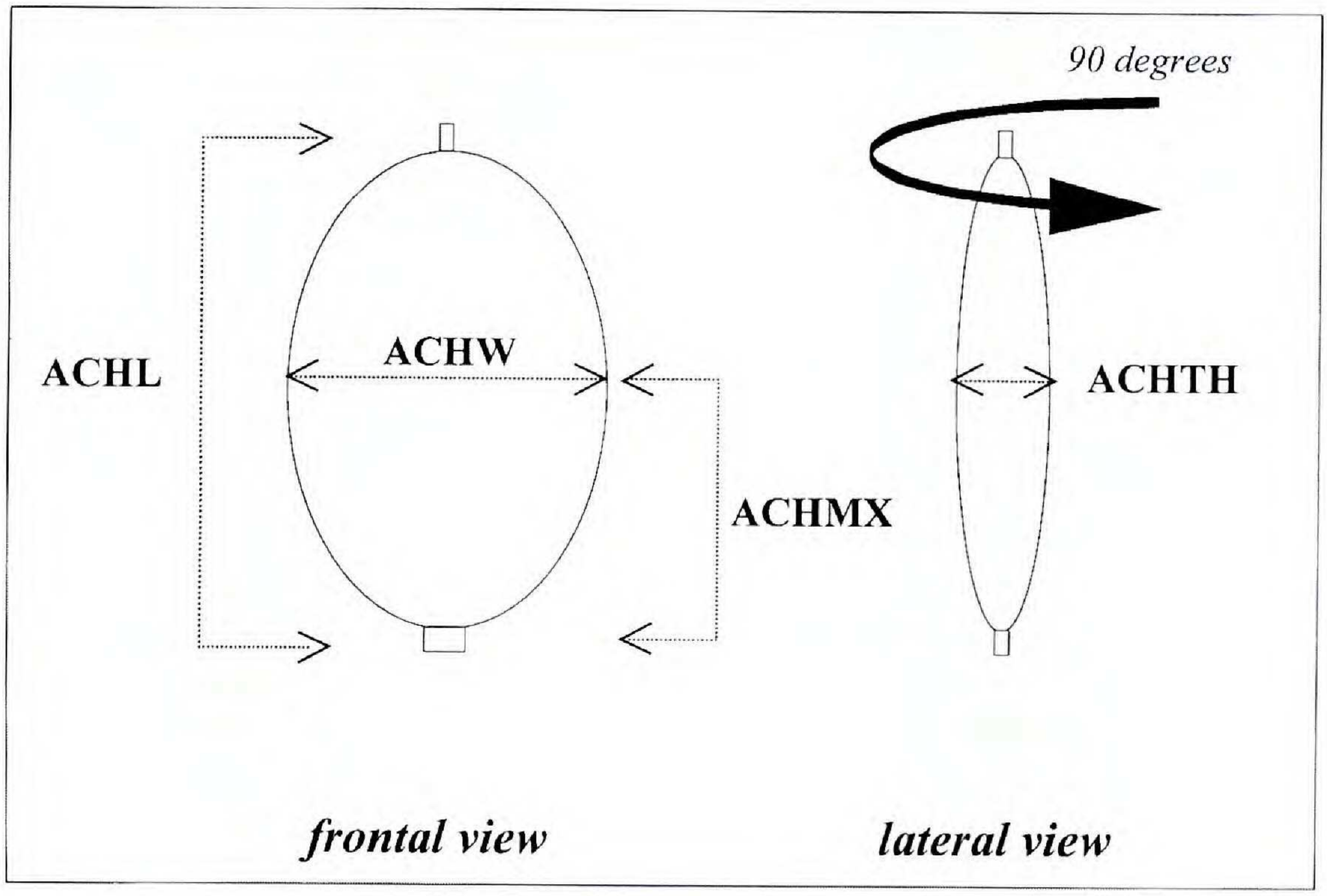

FIG. 1. Frontal and lateral aspects of achene showing dimensions measured in comparing *Cyperus louisianensis* and *C. sanguinolentus*.

TABLE 3. Quantitative characters and ratios employed in analysis of specimens of *Cyperus louisianensis* and *C. sanguinolentus*. Ratios defining plane shapes adapted from Stearn (1992).

ACHL	Achene length (mm)
ACHW	Achene width (mm)
ACHMX	Achene distance from base to widest point (mm)
ACHTH	Achene thickness (mm)
ACHTH/ACHL	Ratio used by Thieret (1977).
ACHL/ACHW	Ratio approximates achene outline, e.g. elliptic (2:1), ovate & obovate (3:2), orbicular (1:1).
ACHL/ACHMX	Ratio approximates achene outline, e.g., elliptic & orbicular (2:1), ovate (<2:1), obovate (>2:1).

southern Mississippi and isolated populations in southern Alabama and southeastern Georgia. *Cyperus louisianensis* appears to be most abundant in Hancock County, Mississippi, and adjacent St. Tammany Parish, Louisiana. Field observations show that *C. louisianensis* is weedy, often locally abundant, and restricted to periodically disturbed habitats, especially those maintained by mowing, such as ditches and edges of artificial ponds, where it appears to be aggressive and frequently forms dense stands often in association with other introduced and native weeds (Table 4).

Greenhouse observations.—In greenhouse experiments, *C. louisianensis* plants emerged from mid- and late May until mid-September each year; plants flowered from late August until mid-December, with peak flowering in early September to early October; and plants subsequently fruited. *Cyperus louisianensis* plants emerging later in the year were shorter at flower initiation than those emerging earlier, suggesting that *C. louisianensis* is photoperiodic. Most of our field collections were made from September 16 through December 9 (see specimen citations for the U.S.A.), with peak fruiting observed and mature plants collected in mid-October; however, a few fruiting plants were observed and/or collected in April and May following a very mild winter (1993–1994). If indeed *C. louisianensis* is photoperiodic, this may account for the few collections of it from May until mid-September by us and by other botanists. All *C. louisianensis* plants transferred into the greenhouse from the field and those grown from seeds in greenhouse experiments died shortly after fruiting, showed no evidence of perennation and, thus, consistently exhibited an annual habit.

Relationship with *Cyperus sanguinolentus*.—Thieret (1977) was limited by a small number of specimens collected from only two sites located less than 10 miles apart. Our larger sample from a wider geographical area shows that *C. louisianensis* is more variable than previously thought in the diagnostic achene characters used by Thieret (1977) to separate it from *C. sanguinolentus*. Figure 2 shows some of the spikelet variation observed in herbarium specimens of *C. sanguinolentus* and *C. louisianensis*. Of the numerous specimens of *C. sanguinolentus* we have examined from throughout the Old World, certain ones from Japan [e.g., *M. Furuse s.n.*, 30 Sep 1959 (GH); *M. Furuse s.n.*, 11 Oct 1960 (GH); *Hutoh 11517* (NY); *Okamoto NSM 584* (BRIT, NY)] are indistinguishable from *C. louisianensis* in general and in spikelet (Fig. 2) and achene characteristics used by Thieret (1977). Our field and herbarium observations show considerable variation in the degree of development of pigmentation and *sulcus* in floral scales. At least some of the variation in floral scale pigmentation appears related to photoperiod and temperature. Field observations in the southeastern United States show that in mid-September the floral scales are typically pale with only faint pigmentation, and by mid-October they are deeply pigmented (cf. Figs. 2A and 2B). Opposite sides of an individual spikelet may also vary greatly in pigmentation (cf. Figs. 2G and 2H). Scatter diagrams (Figs. 3–6) show *C. louisianensis* and *C. sanguinolentus* are indistinguishable with regard to the critical achene characteristics used by Thieret (1977) to separate them.

DISCUSSION

Cyperus louisianensis is widely distributed in the coastal plain of the southeastern United States and is often locally abundant in habitats subject to periodic artificial disturbance and maintenance. Distribution, frequency, and habitat of *C. louisianensis* are indicative of a semi-aggressive weed, not of a narrow endemic species. Furthermore, it appears that the range of this taxon is apparently expanding in the southeastern United States and that its dispersal has possibly resulted in part from road construction and maintenance

TABLE 4. Composite list of taxa associated with *Cyperus louisianensis* in the southeastern United States.

Acer rubrum L.
Acmella oppositifolia (Lam.) Jansen
Andropogon virginicus L.
Aneilema nudiflora (L.) Brenan
Aster tenuifolius L.
Axonopus fissifolius (Raddi) Kuhlm.
Bacopa caroliniana (Walt.) Robins.
Boehmeria cylindrica (L.) Sw.
Boltonia diffusa Ell.
Carex longii Mack.
Centella asiatica (L.) Urb.
Colocasia esculenta (L.) Schott
Cuphea carthagensis (Jacq.) Macbr.
Cyperus compressus L.
C. croceus Vahl
C. cuspidatus H.B.K.
C. difformis L.
C. distinctus Steud.
C. elegans L.
C. esculentus L.
C. filicinus Vahl
C. flavescens L.
C. flavicomus Michx.
C. haspan L.
C. iria L.
C. odoratus L.
C. ovatus Baldwin
C. pilosus Vahl
C. polystachyos Rottb.
C. pseudovegetus Steud.
C. retrorsus Chapm.
C. rotundus L.
C. strigosus L.
C. surinamensis Rottb.
C. virens Michx.
Dichondra sp.
Diodia spp.
Echinochloa spp.
Eclipta prostrata (L.) L.
Eleocharis microcarpa Torr.
E. obtusa (Willd.) Schult.
E. quadrangulata (Michx.) R. & S.
E. tuberculosa (Michx.) R. & S.
Eleusine indica (L.) Gaertn.
Erigeron vernus (L.) T. & G
Fimbristylis annua (All.) R. & S.
F. autumnalis (L.) R. & S.
F. decipiens Kral
F. miliacea (L.) Vahl
F. tomentosa Vahl
Conoclinum coelestinum (L.) DC.
Fuirena breviseta (Cov.) Cov.
Gratiola sp.
Hedyotis uniflora (L.) Lam.
Hydrocotyle umbellata L.
Ipomoea sp.
Iva annua L.
Jacquemontia tamnifolia (L.) Griseb.
Juncus spp.
Kyllinga brevifolia Rottb.
K. odorata Vahl
K. pumila Michx.
Leersia hexandra Swartz
Lilaeopsis sp.
Lippia nodiflora (L.) Greene
Ludwigia octovalvis (Jacq.) Raven
L. repens J.R. Forst.
Lycopus sp.
Magnolia virginiana L.
Mikania scandens (L.) Willd.
Mitreola sessilifolia (Gmel.) G. Don
Myrica cerifera L.
Oxypolis filiformis (Walter) Britt.
Panicum repens L.
Paspalum notatum Flüggé
P. urvillei Steud.
Phyllanthus urinaria L.
Polygonum hydropiperoides Michx.
Polypremum procumbens L.
Rhynchospora corniculata (Lam.) Gray
Sacciolepis indica (L.) Chase
Sagittaria sp.
Salix nigra Marshall
Scleria reticularis Michx.
Setaria sp.
Solidago sp.
Sorghum halapense (L.) Pers.
Sporobolus indicus (L.) R. Br.
Stenotaphrum secundatum (Walt.) Kuntze
Urochloa platyphylla (Munro) Webst.

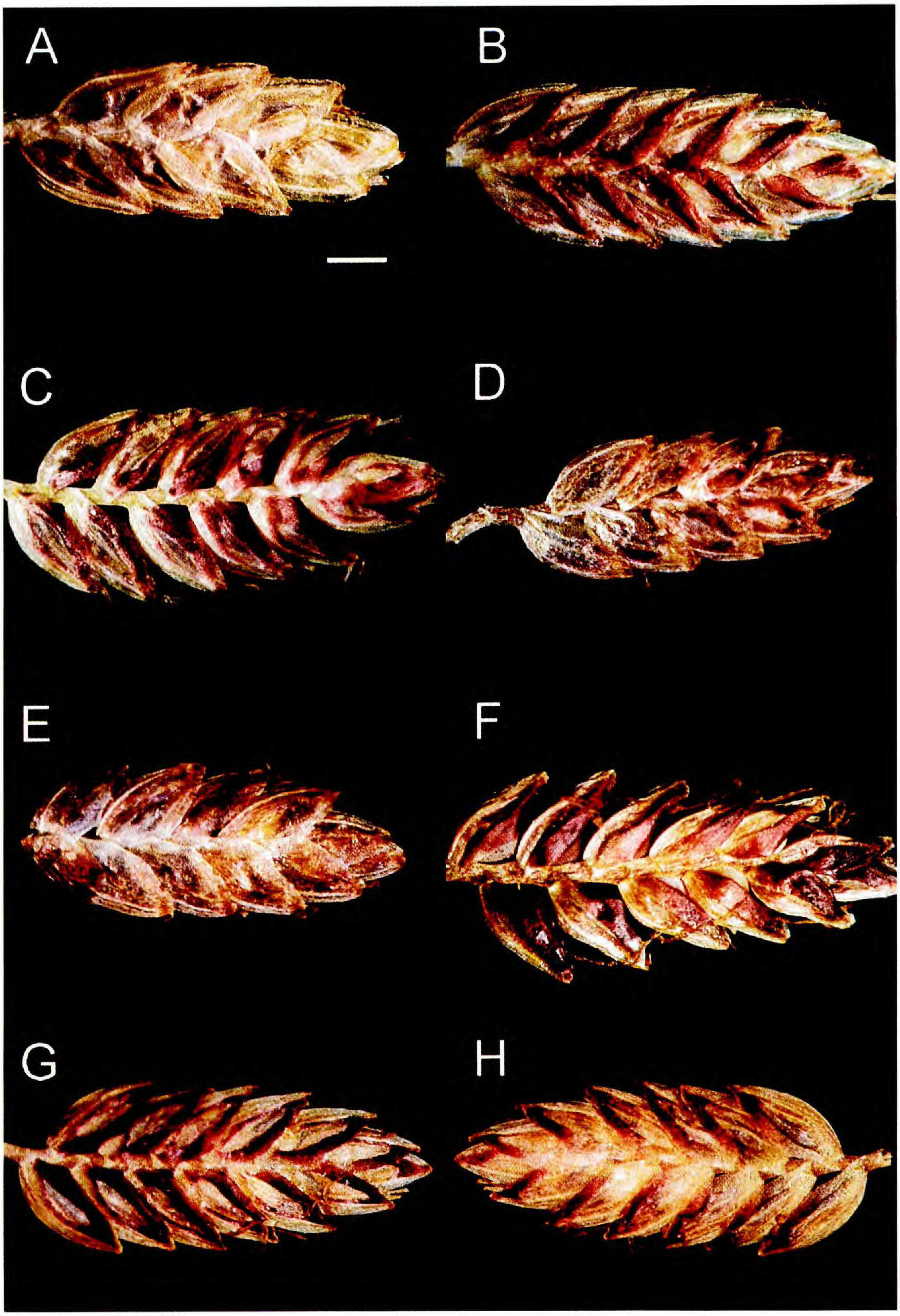

FIG. 2. Spikelet variation in *Cyperus sanguinolentus* and *C. louisianensis*.–A. U.S.A., 16 September 1993, *Carter 11342*.–B. U.S.A., 18 October 1993, *Carter 11562*.–C. U.S.A., *Carter 11579*.–D. Japan, 11 Oct 1960, *M. Furuse s.n.*–E. Japan, *Hotoh 11517*.–F. China, *Tsang 20665*.–G & H. Opposite sides of same spikelet, Japan, *K. Okamoto NSM 584*. Scale bar = 1 mm.

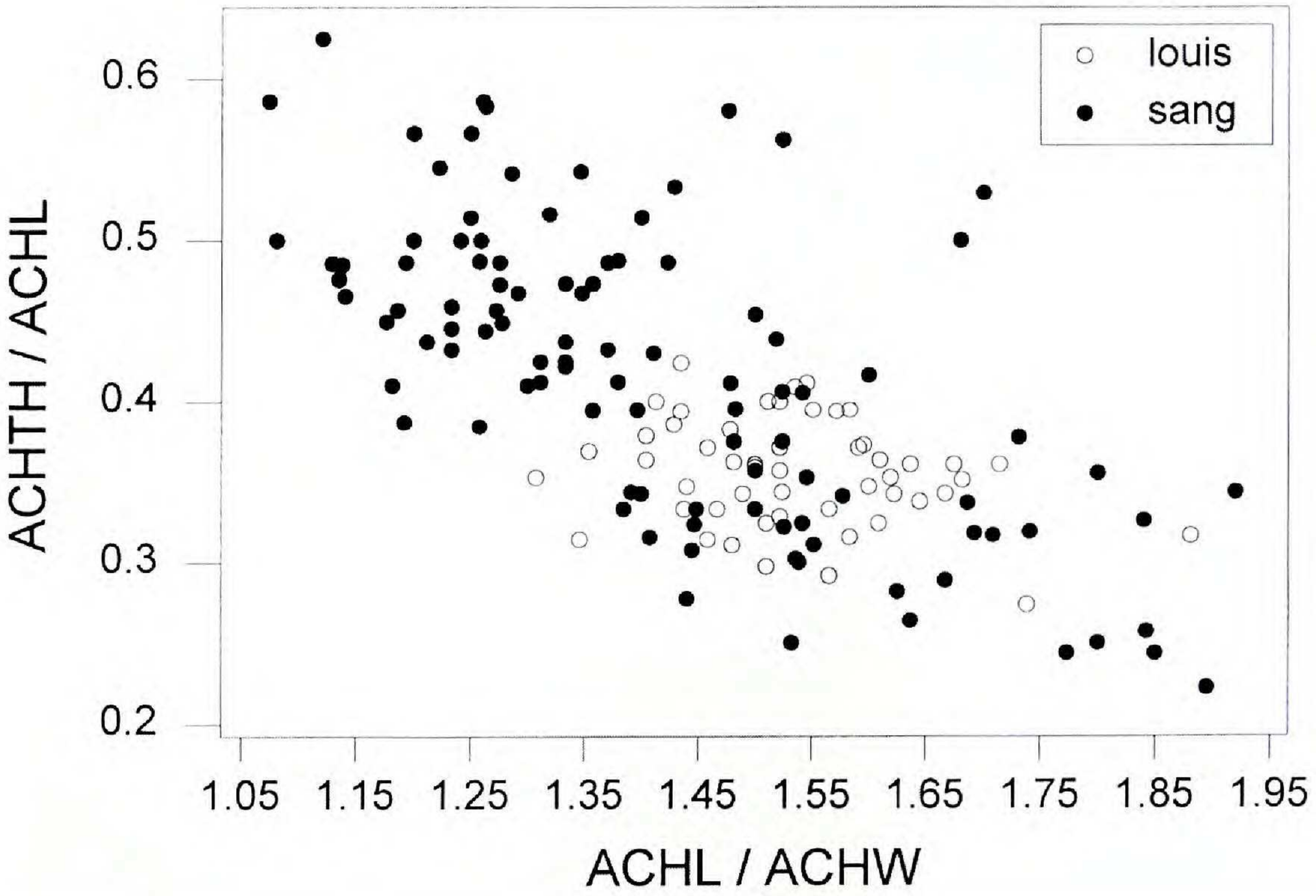

FIG. 3. Two-dimensional scatter diagram showing relationship between *Cyperus sanguinolentus* and *C. louisianensis* with regard to critical ratios defining achene shape; character abbreviations keyed in Table 2.

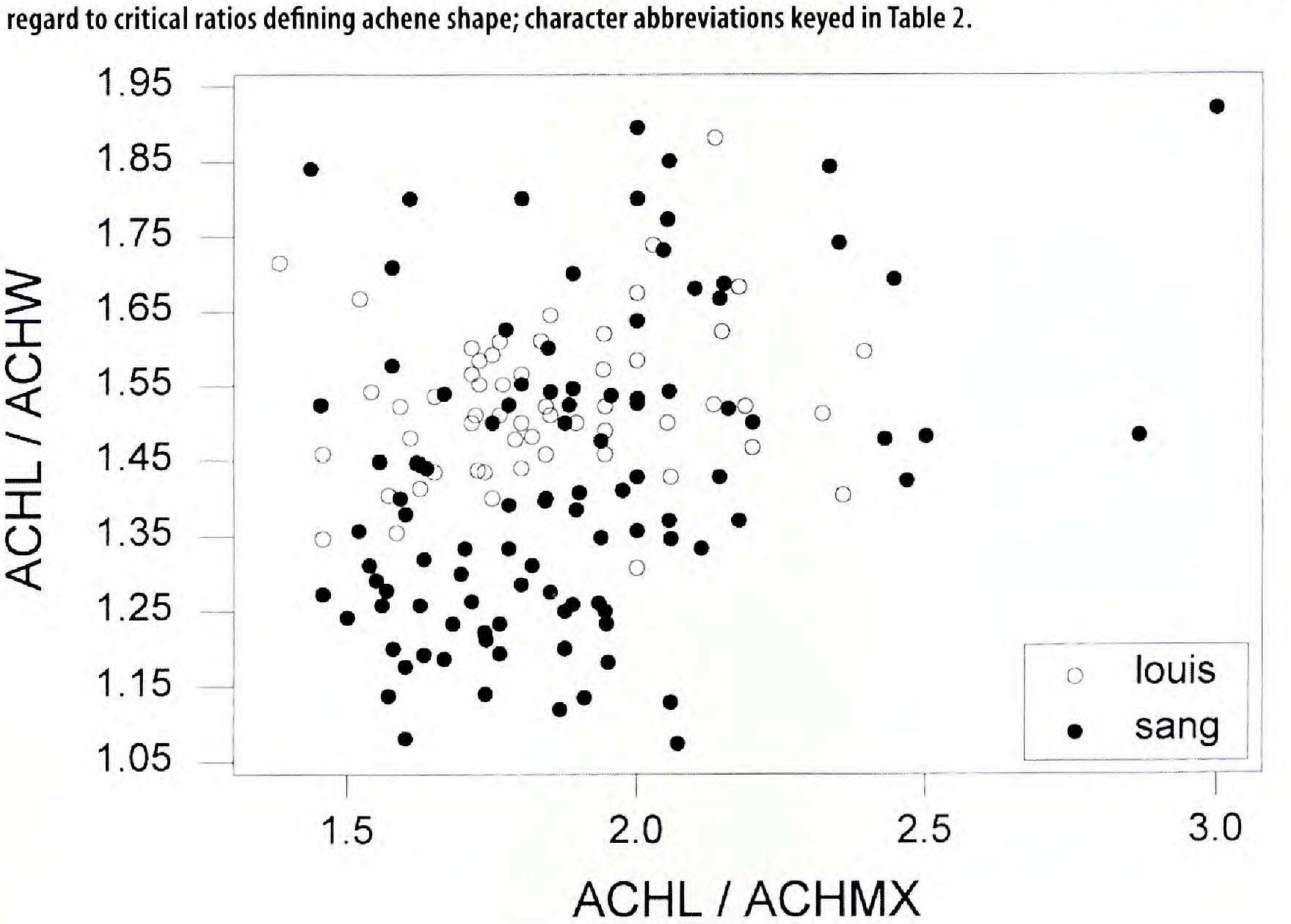

FIG. 4. Two-dimensional scatter diagram showing relationship between *Cyperus sanguinolentus* and *C. louisianensis* with regard to critical ratios defining achene shape; character abbreviations keyed in Table 2.

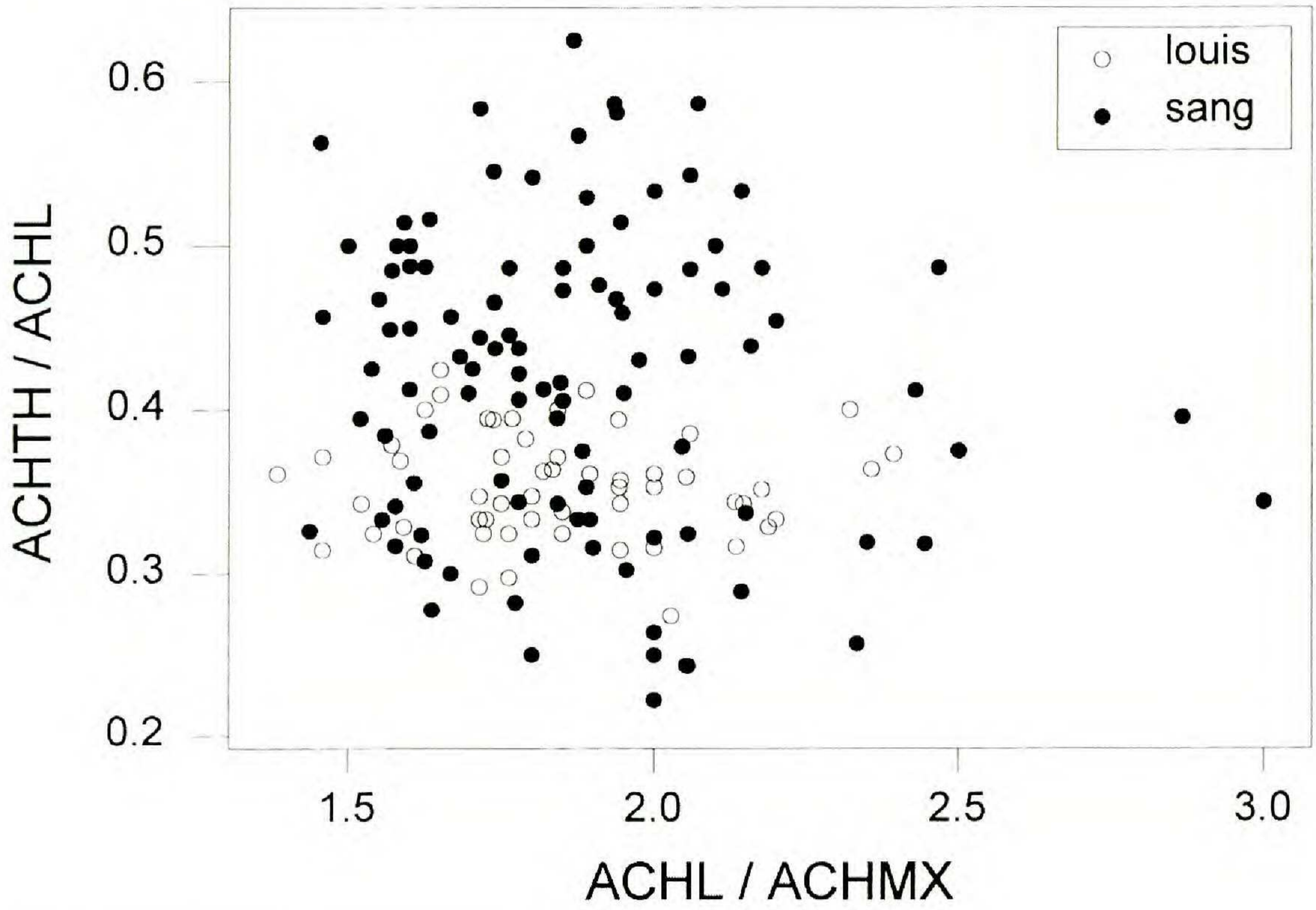

FIG. 5. Two-dimensional scatter diagram showing relationship between *Cyperus sanguinolentus* and *C. louisianensis* with regard to critical ratios defining achene shape; character abbreviations keyed in Table 2.

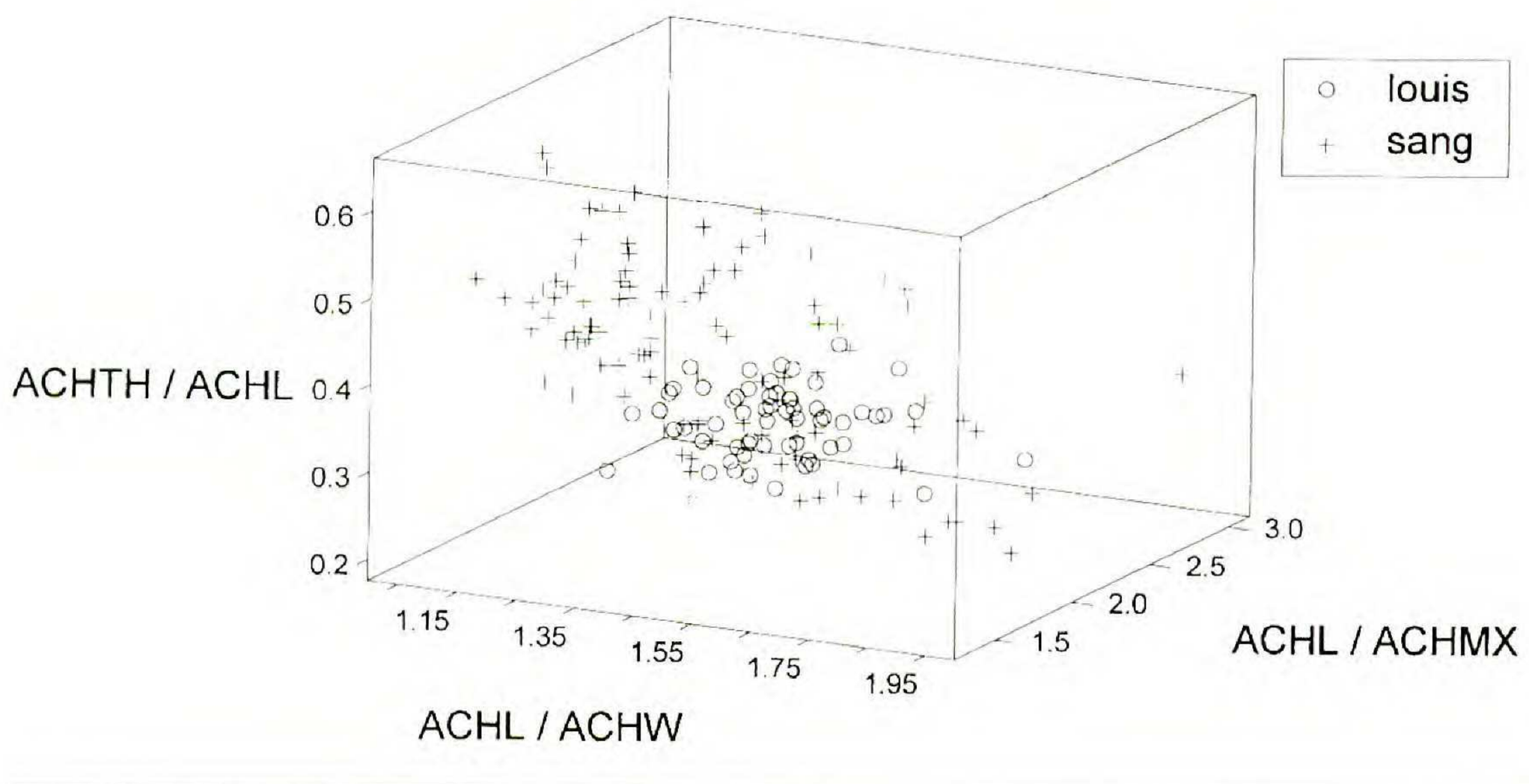

FIG. 6. Three-dimensional scatter diagram showing relationship between *Cyperus sanguinolentus* and *C. louisianensis* with regard to three critical ratios defining achene shape; character abbreviations keyed in Table 2.

activities, as suggested for *C. entrerianus* Boeck. (Carter 1990). At Kings Bay Submarine Base, where extensive populations were found in Camden County, Georgia, road rights-of-way are maintained by work crews traveling from Alabama under contractual service agreements with the Department of Defense (pers. comm., R. Wilkerson). Thus, it is possible that achenes of *C. louisianensis* were accidentally dispersed into Georgia from Alabama, or elsewhere, with the transport of mowing equipment.

Thieret (1977) distinguished *C. louisianensis* from *C. sanguinolentus* based on its more overlapping floral scales and its more elliptical and more flattened achenes (Table 2). Our results indicate the New World populations called *C. louisianensis* are encompassed within the total range of variation exhibited by the more variable widespread Old World weed, *C. sanguinolentus*, and are most similar to certain specimens from Japan. Furthermore, as shown in Figures 3–6, the United States specimens are less variable than those from the Old World, which is consistent with the "founder principle" (Mayr 1942; Davis & Heywood 1973) and would be expected in a case of accidental long-distance dispersal. Although typification of the plethora of synonyms and accepted infraspecific names under *C. sanguinolentus* (Table 1) is beyond the scope of this study, it appears the United States specimens are closest to *C. sanguinolentus* var. *sanguinolentus* (*fide* Kükenthal 1935–1936) or *C. sanguinolentus* ssp. *sanguinolentus* (*fide* Kern 1974).

The presence of *C. sanguinolentus* in the southeastern United States is not unexpected for the following reasons. (1) It has been cited as an agricultural weed in the Eastern Hemisphere (Mingyuan & Dehu 1970; Kern 1974; Kühn 1982; Holm et al. 1991). (2) Reed (1977) listed it among foreign weeds posing "potential problems in the United States." (3) There are numerous other examples of weedy *Cyperus* spp. and other sedges in the southeastern United States introduced from Asia or elsewhere (Carter 1990; Bryson & Carter 1992; Bryson & Carter 1994; Carter et al. 1996; Carter & Bryson 1996; Bryson et al. 1996; Bryson et al. 1997; McKenzie et al. 1998). (4) Kral (1971) reported *Fimbristylis* spp. (Cyperaceae), common in current and former rice-growing areas of the United States, that were likely introduced from Asia with rice (*Oryza sativa* L.) agriculture. (5) Historically, rice was grown in Hancock County, Mississippi, where *C. louisianensis* is most abundant (Anonymous 1959, 1982).

CONCLUSIONS

Cyperus louisianensis is much more widespread than previously thought (Thieret 1977; Bryson & Carter 1994). It is locally common in southern Mississippi and southeastern Louisiana, and satellite populations have been found in southern Alabama and southeastern Georgia. Its habitat and frequency are characteristic of a weed, and its range and frequency are likely to increase, particularly in the outer Coastal Plain of the southeastern United States.

Specimens of *C. louisianensis* from the United States are morphologically indistinguishable from certain Old World specimens of *C. sanguinolentus*. Thus, we think the two are conspecific and treat *C. louisianensis* as a synonym of *C. sanguinolentus*. Herein, we

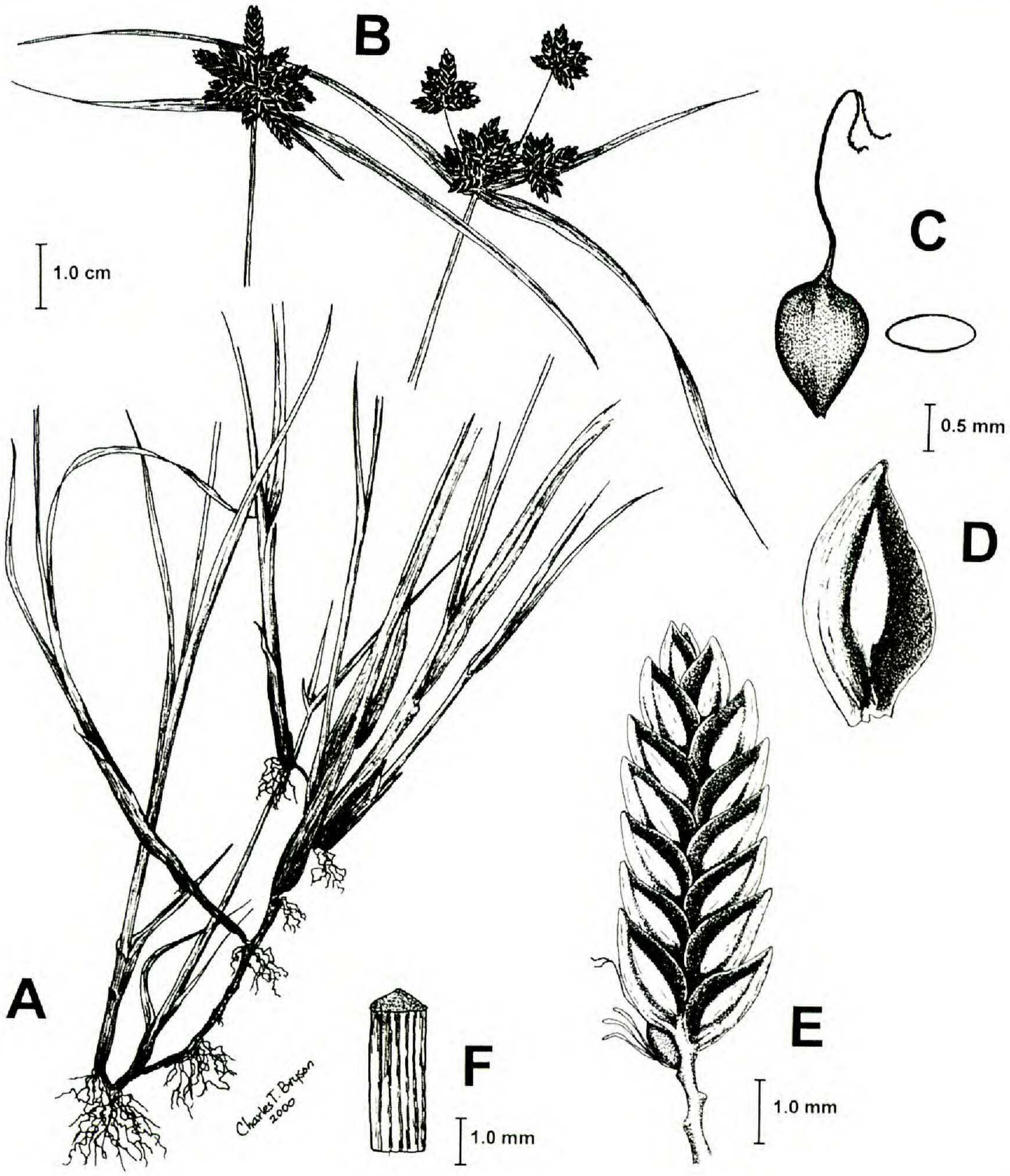

FIG. 7. *Cyperus sanguinolentus* Vahl.–A. Habit, base of plant (*Bryson 14608 & MacDonald*).–B. Inflorescences (left, *Bryson 14610 & MacDonald*; right, *Bryson 13276*).–C. Achene with stigma, style, and cross section outlined (*Bryson 13276*).–D. Floral scale (*Bryson 13276*).–E. Spikelet (*Bryson 13276*).–F. Stem section (*Bryson 13276*).

report *C. sanguinolentus* (including *C. louisianensis*) as new to the United States and North America and provide revised synonymy, description, illustration (Fig. 7), distribution map (Fig. 8), and specimen citations. Additional duplicates collected by the authors will be distributed later.

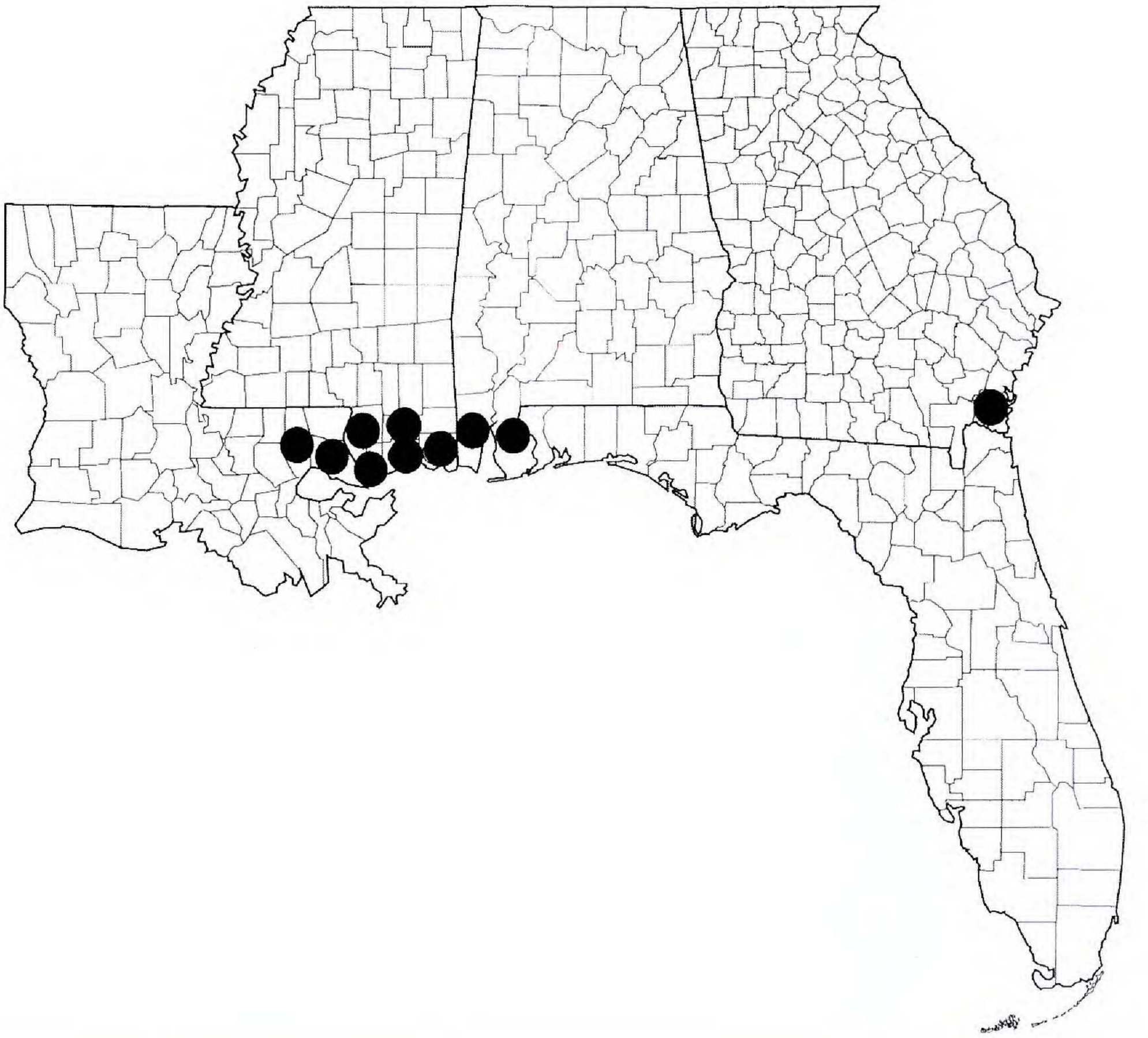

FIG. 8. Distribution by county of *Cyperus sanguinolentus* in the southeastern United States.

DICHOTOMOUS KEY TO *CYPERUS SANGUINOLENTUS* AND RELATED NORTH AMERICAN SPECIES

1a. Floral scales membranous, bilaterally sulcate (with two narrowly elliptic translucent lateral grooves); floral scales usually at least marginally suffused with reddish pigmentation.

2a. Stamens 2; style divided nearly to base; style branches conspicuously exserted beyond floral scale, exposed portions about as long as floral scale; plants cespitose; plants of northeastern and upper mid-western United States. _____ **C. diandrus** Torr.

2b. Stamens 3; style divided less than half its length; style branches not so conspicuously exserted, exposed portions less than half as long as floral scale; plants decumbent, appearing stoloniferous by development of series of lateral branches from lower nodes; plants of southeastern United States. _____ **C. sanguinolentus** Vahl

1b. Floral scales firmer, subcoriaceous, not laterally sulcate; floral scales usually brownish, blackish or reddish with pigmentation more-or-less uniformly distributed.

3a. Inflorescence usually appearing capitate; style divided less than half its length; style branches inconspicuous; bracts divaricate to reflexed; plants rhizomatous; plants ranging from southwestern United States southward through much of tropical America. _____ **C. niger** Ruiz & Pav.

3b. Inflorescence usually with 1 or more pedunculate rays; style divided more than half its length; style branches conspicuous, mostly projecting beyond floral scale; bracts mostly divaricate to spreading; plants cespitose, usually in spreading clumps; plants widespread in United States. _____ **C. bipartitus** Torr.

Cyperus sanguinolentus Vahl, Enum. Pl. 2:351. 1805. *Pycreus sanguinolentus* (Vahl) Nees, Linnaea 9:283. 1835. TYPE: INDIA. UTTAR PRADESH: NW Himalaya, Distr. Tehri-Garhwál, 3000 ft, Oct 1894, *Gamble 15117* (L) [typ. cons. prop., Kukkonen 1995].

Cyperus louisianensis J.W. Thieret, Proc. Louisiana Acad. Sci. 40:23. 1977. TYPE: U.S.A. LOUISIANA. Tangipahoa Parish: ca. 7 mi E of Ponchatoula, along road to Lee's Landing, 1 Oct 1972, *Thieret 33585* (Holotype: GH!; Isotypes: DUKE, KNK, LAF, NC, OS). PARATYPES: U.S.A. LOUISIANA. Tangipahoa Parish: junction of Ponchatoula-Madisonville highway and road to Lee's Landing, ca. 7 mi E of Ponchatoula, 18 Oct 1970, *Thieret 32609* (DUKE, GH!, KNK).

Annual herb, appearing stoloniferous by repeated development of decumbent vegetative lateral branches from lower nodes. Stems (6.5–)12–38(–60) cm long, 0.7–2.0 mm wide, trigonous. Leaves (1–)3–7; bases sheathing; blades linear, (3–)5–11(–16.5) cm long, (1–)2–3.5 mm wide. Primary inflorescence bracts 2–3(–4), linear; longest (1–)3–12(–19) cm long, 1–3 mm wide. Inflorescence terminal, usually appearing capitate, or with 1–3 pedunculate rays to 4 cm long. Spikelets narrowly ovate-elliptic, 4–10(–15) mm long, 2.2–3.0 mm wide, with 8–32 floral scales. Floral scales mostly closely imbricate, membranous, ovate, 1.8–2.7 mm long, carinate; keel green, 3–5 nerved; sides variable in color, usually variegated whitish, reddish brown to sanguineus, each with a narrowly elliptic translucent sulcus devoid of pigment; reddish pigment and sulcus generally becoming more conspicuous late season. Stamens 3; anthers 0.3–0.6 mm long. Style bifid one-third to one-half its length; stigmas exserted. Achene lenticular, biconvex, 1.0–1.4 mm long, 0.6–0.9 mm wide, 0.3–0.5 mm thick, elliptic to obovate, usually asymmetrical near apex along side adjacent to rachilla; surface reticulate, grayish brown to brown. Fig. 7.

Distribution and habitat.—Widely distributed weed in tropical and subtropical regions of the Eastern Hemisphere; central and eastern Asia, Japan, southeastern Asia, Indonesia, Malaysia, Philippines, Australia, and eastern Africa. Introduced into the outer coastal plain of the southeastern United States of North America, ranging from southeastern Louisiana into southwestern Alabama with an isolated station in southeastern Georgia (Fig. 8). In the southeastern United States often locally common and weedy in periodically disturbed sites with high hydro-period soils (e.g., road ditches, margins of artificial ponds, etc.).

Phenology.—In the southeastern United States, flowering and fruiting from September until frost and sporadically earlier.

Specimens examined. **North America. U.S.A. ALABAMA. Baldwin Co.:** Foley, 17 Sep 1994, *Burkhalter 14368* (VSC). **Mobile Co.:** Mobile, Battleship Park, Hwy. US 90, 30 May 1994, *Mears 94-25* (ctb, VSC); 12 Sep 1995, *Carter 12705* (VSC). **GEORGIA. Camden Co.:** Kings Bay Submarine Base, 0.2 mi E jct. U.S.S. Henry L. Stimson Dr. and James Madison Rd., U.S.S. Henry L. Stimson Dr., 11 Oct 1996, *Carter 13873* (VSC); just N jct. U.S.S. Benjamin Franklin Rd. and U.S.S. Georgia Ave., U.S.S. Georgia Ave., 25 Oct 1996, *Carter 13939* (VSC); ca. 100 m N jct. U.S.S. Benjamin Franklin Rd. and U.S.S. James Madison Rd., U.S.S. James Madison Rd., 25 Oct 1996, *Carter 13940* (VSC); ca. 200 m S jct. U.S.S. Henry L. Stimson Dr. and U.S.S. Kamehameha Ave., U.S.S. Kamehameha Ave., 25 Oct 1996, *Carter 13941* (VSC); 0.09 mi N jct. U.S.S. Daniel Webster Rd. and U.S.S. Benjamin Franklin Rd., U.S.S. Daniel Webster Rd., 25 Oct 1996, *Carter 13954* (VSC); ca. 300 m E Franklin Gate, S side U.S.S. Benjamin Franklin Rd., 4 Dec 1996, *Carter 13962* (VSC). **LOUISIANA. St. Tammany Parish:** Goodbee, 12 Oct 1960, *Hebert 377* (MISS); Hwy. US 190, 0.35 mi E jct. Hwy. US 190 and LA 1077 in Goodbee, 18 Sep 1993, *Carter 11367* (VSC); Slidell, Hwy. US 190E, 0.84 mi W jct. Hwy. US 190E and I-10, 15 Oct 1993, *Carter 11490* (VSC); Slidell, ICG Railroad right-of-way, 0.14 mi N jct. Hwys. LA 433 and US 11, 15 Oct 1993, *Carter 11505* (VSC); Slidell, Hwy. US 190, 0.10 mi W jct. Hwys. US 190 and US 11, 16 Oct 1993, *Carter 11539* (VSC); Slidell, Hwy. US 190, 1.4 mi W jct. Hwys. US 190 and US 11, 16 Oct 1993, *Carter 11540* (VSC); Lacombe, Hwy. US 190 at Tranquility Road, 16 Oct 1993, *Carter 11541* (VSC); Slidell, Hwy. US 11, 250 ft. S jct. Hwy. US 11 and Carollo Avenue, 17 Oct 1993, *Carter 11558 & Bryson* (VSC), *Bryson 13218 & Carter* (ctb, VSC); Slidell, Hwy. I-10, S jct. Hwys. I-10 and US 190, 17 Oct 1993, *Carter 11561 & Bryson* (VSC); Slidell, SW jct. Hwys. I-10 and LA 533, 17 Oct. 1994, *Bryson 14565 & MacDonald* (ctb, VSC). **Tangipahoa Parish:** ca. 7 mi SE Ponchatoula, ca. 1 mi N Lees Landing, 16 Nov 1989, *Gilmore 3977* (VSC), *Gilmore 3978* (ctb, VSC); 19 Sep 1993, *Carter 11374* (VSC); Ponchatoula, Hwy. LA 22, 0.5 mi E jct. LA 22 and North First Street, 17 Sep 1993, *Carter 11355* (VSC); Ponchatoula, Hwy. LA 22, W jct. Hwy. LA 22 (E. Pine Street) and West Street, 18 Sep 1993, *Carter 11372* (VSC). **MISSISSIPPI. Hancock Co.:** Hwy. MS 43, 0.44 mi N jct. Hwy. US 90 and MS 43 in Waveland, 16 Sep 1993, *Carter 11342* (VSC); 0.8 mi N jct. US 90 and MS 43 in Waveland, 16 Oct 1993, *Bryson 13166 & Carter* (ctb, SWSL, VSC), 17 May 1994, *Bryson 13535* (ctb, VSC); Hwy. MS 43, 5.25 mi E jct. Hwys. MS 43 and I-59 in Picayune, 18 Oct 1993, *Carter 11567 & Bryson* (VSC), *Bryson 13265 & Carter* (ctb, SWSL, VSC); 9.0 mi NW jct. Hwys. 43 and 603 in Kiln, Hwy. MS 43, pipeline crossing, 18 Oct 1993, *Carter 11568 & Bryson* (VSC); 17 May 1994, *Bryson 13542* (ctb, VSC); 21 Oct 1997, *Bryson 16217* (ctb, SWSL, VSC); N of Kiln, 0.6 mi. S jct. of Hwys. MS 43 and MS 603, 18 Oct 1993, *Bryson 13267 & Carter* (ctb, SWSL); Kiln, Hwy. MS 43, 0.6 mi S jct. Hwys. MS 43 and MS 603, 18 Oct 1993, *Carter 11569 & Bryson* (VSC); Kiln, Hwy. MS 43, vicinity Shifalo Baptist Church and Kiln Post Office, 18 Oct 1993, *Carter 11570 & Bryson* (VSC), *Bryson & Carter 13268* (ctb, SWSL, VSC); 21 Oct 1997, *Bryson 16216* (ctb, VSC); jct. of Hwys. MS 43 and I-10 between Kiln and Waveland, 18 Oct 1993, *Carter 11571 & Bryson* (VSC); SE jct. Hwys. I-10 and MS 43, 18 Oct 1993, *Bryson & Carter 13271* (ctb, SWSL, VSC), 17 May 1994, *Bryson 13534* (ctb, VSC); E of Picayune, 5.8 mi E jct. Hwys. I-59 and MS 43, 16 Oct 1994, *Bryson 14537 & MacDonald* (ctb, SWSL, VSC); Mississippi Welcome Center, SE jct. Hwys. I-10 and MS 607, 17 Oct 1994, *Bryson 14567 & MacDonald* (ctb, SWSL, VSC); Kiln, NW jct. Hwy. MS 43 and Kiln-Delisle Road, 17 Oct 1994, *Bryson 14597 & MacDonald* (ctb, SWSL, VSC); Waveland, Nicholson Avenue, 0.2 mi S jct. Hwys. US 90 and MS 43, 18 Oct 1994, *Bryson 14608 & MacDonald* (ctb, SWSL, VSC); Waveland, Central Avenue, between Central Avenue and RR just W Washington Street, 18 Oct 1994, *Bryson 14610 & MacDonald* (ctb, SWSL, VSC); Waveland, NW jct. Hwys. US 90 and MS 43, 7 Dec 1994, *Bryson 14709* (ctb, SWSL, VSC); Waveland, NW jct. Hwys. US 90 and MS 43, 21 Oct 1997, *Bryson 16214* (ctb, VSC), 20 Nov 1998, *Bryson 16939 & Sudbrink* (ctb, SWSL, VSC); Waveland, 1.2 mi S Hwy. US 90 on Nicholson Avenue, then 1.6 mi E on Central Avenue, 21 Oct 1997, *Bryson 16215* (ctb, SWSL, VSC). **Harrison Co.:** Orange Grove Community Center Park, W Hwy. US 49, 0.3 mi N jct. Hwys. US 49 and I-10, 16 Oct 1993, *Bryson 13164 & Carter* (ctb, SWSL, VSC), *Carter 11544 & Bryson* (VSC); Orange Grove, Hwy. US 49, 1.1 mi S jct. Hwy. US 49 and O'Neal Road, 18 Oct 1993, *Bryson 13276* (ctb, SWSL, VSC); N Gulfport, Harrison Drive, 0.3 mi W jct. Harrison Drive and M.L. King Jr. Blvd., 18 Oct 1993, *Carter 11574* (VSC); Popps Ferry Road, 3.32 mi

W jct. Popps Ferry Road and D'Iberville Boulevard (Hwy. MS 67), 18 Oct 1993, *Carter 11577* (VSC); NW jct. Hwys. I-10 and US 49, 18 Oct 1993, *Bryson 13279* (ctb, SWSL, VSC); Long Beach, SE jct. Klondyke and Commission Road, 18 Oct 1994, *Bryson 14606 & MacDonald* (ctb, SWSL, VSC). **Jackson Co.:** Pascagoula, SE jct. Washington Ave. and Louise St., vic. Bayou Casotte, T8S R5W S17, 16 Sep 1991, *Bryson 11032* (ctb, NY, NYS, VSC); 16 Sep 1993, *Carter 11337* (VSC); St. Martin, Rosefarm Road, 0.2 mi N jct. Old Fort Bayou Road and Rosefarm Road, 18 Oct 1993, *Carter 11579* (VSC); vicinity St. Martin, 1.13 mi W jct. Old Fort Bayou Road and Yellow Jacket Boulevard, 18 Oct 1993, *Carter 11580* (VSC); vicinity St. Martin, Old Fort Bayou Road, 0.19 mi E jct. Old Fort Bayou Road and Yellow Jacket Drive, 18 Oct 1993, *Carter 11581* (VSC); Pascagoula, 16 Oct 1994, *Bryson 14547 & MacDonald* (ctb, VSC); Moss Point, SE jct. Hwys. I-10 and MS 63, 16 Oct 1994, *Bryson 14550 & MacDonald* (ctb, SWSL, VSC); Latimer, 1.2 mi N jct. Hwys. I-10 and MS 609, 1.2 mi N Tucker and Cook Roads, along Tucker Road, 16 Oct 1994, *Bryson 14559 & MacDonald* (ctb, SWSL, VSC); Pascagoula, on Hwy. US 90, 1.5 mi. W jct. of Hwys. US 90 and MS 63, 6 Nov 1994, *MacDonald 8195 & Leidolf* (ctb, SWSL); N Ocean Springs, Hwy. I-10, E mi marker 50, 19 Oct 1994, *Bryson 14636* (ctb, SWSL, VSC). **Pearl River Co.:** Picayune, Hwy. MS 43, 0.50 mi W jct. Hwys. MS 43 and I-59, 18 Oct 1993, *Carter 11562* (VSC), 28 Oct 1998, *Bryson 16874 & Sudbrink* (ctb, VSC); Picayune, frontage road W Hwy. I-59, ca. 250 m N jct. Hwys. MS 43 and I-59, 18 Oct 1993, *Bryson 13222 & Carter* (ctb, SWSL, VSC), *Carter 11565 & Bryson* (VSC), 29 Oct 1998, *Bryson 16900 & Sudbrink* (ctb, SWSL, VSC), 9 Nov 1999, *Bryson 17730 & Sudbrink* (ctb, SWSL, VSC); Picayune, N side of Hwy. MS 43, 0.5 mi. W jct. of Hwys. MS 43 and I-59, 18 Oct 1993, *Bryson 13257 & Carter* (ctb, SWSL, VSC); Picayune, SW jct. Hwys. I-59 and MS 43 S, 19 Oct 1994, *Bryson 14634* (ctb, SWSL, VSC); Picayune, 21 Oct 1997, *Bryson 16212* (ctb, VSC); Picayune, 21 Oct 1997, *Bryson 16213* (ctb, VSC). **Stone Co.:** Wiggins, NW jct. Hwys. US 49 and MS 26, 22 Oct 1997, *Bryson 16219* (ctb, VSC).

EURASIA. RUSSIA. Primorski, Distr. Michaelowsky, Repevka Valley, 12 Sep 1929, *Baianova 647* (NY). **BHARAT (INDIA).** Bengal, *Griffith s.n.* (NY); Hassan District, Mysore, tank near Dandiganahalli, 11 Nov 1971, *Hooper & Gandhi HFP 2401* (MO); Sikkim, *J.D. Hooker s.n.* (NY); Maharashtra, Nagpur, Ambala, 2-10-1962, *Donde D28* (NY); Chamba, Khajiar, 11.7.1936, *Koelz 8833* (NY); Pahlgam, 16 Aug 1920, *Stewart & Stewart 5709* (NY); Srinagar, Dal Lake, 13 Jul 1917, *Stewart 3274* (NY); Kulu, Rotang Pass, Sep 1930, *Koelz 1359* (NY). **PAKISTAN.** Baltistan, ca. 1.5 mi E Skardu, alt. Ca. 7500 ft, 26 Aug 1955, *Webster 6585* (GH); Skardu to Shigar, 8 Jul 1940, *Stewart 20472* (NY); Kishenganga Valley and road to Nanga Parbat, below Wangat, Sind Vy., 7 Aug 18080, *Stewart & Stewart 18080* (NY). **NEPAL.** Kali Gandaki, *Stainton, Sykes & Williams 9238* (GH, NY); Kali Gandaki, Tatopani, S of Dana, 30 Aug 1954, *Stainton, Sykes & Williams 7591* (NY); Bongakhani, 22 Aug 1954, *Stainton, Sykes & Williams 3954* (BRIT, NY); Aruna Valley, Sedua, NW of Num, 31 May 1956, *Stainton 485A* (NY); Samri Khola, 7 Apr 1953, *Gardner 141* (NY); Argam, near Pokhara, 11.9.1954. *Stainton, Sykes & Williams 7178* (NY); Jajarkot District, Maina gaon, 12 Aug 1979, *Rajbhandara & Roy 4585* (NY); Rukum District, Gija gaon, 18 Sep 1982, *Rajbhandara & Malla 6535* (NY); Sindjuli District, Patlebhanjyang, 22 Dec 1975, *Shakya & Rajbhandara 3343* (NY); Dolakha District, Lamabagar to Hum, 16 Jul 1977, *Rajbhandara & Roy 1538* (NY). **CEYLON.** Amparia District, Senanaike Samudra, Padagoda, 6 Feb 1971, *Koyama 13983* (GH); Peradeniya, 29 Dec 1967, *Comanor 690* (NY); Central Province, Kandy District, ca. 5 mi SE Gampola, 24 Oct 1974, *Davidse & Sumithraarachchi 7924* (NY); Sabaragamuwa Prov., Ratnapura District, 11 mi E Deniyaya, 22 Oct 1974, *Davidse 7886* (MO, NY); Northwestern Prov., Wilpattu National Park, Manikepola Uttu, 24 Mar 1968, *Heart & Cooray 13460* (NY); Amparai District: Senanaike Samudra, Padagoda, 6 Feb 1971, *Koyama & Balakrishnan 13983* (NY). **CHINA.** Prov. Hainan, Janfengling, *Chow 78471* (GH); Prov. Hunan Sheng, Xinning Xian, Ziyun Shan, 13 Sep 1984, *Li Zhen-yu et al. 1826* (MO); Prov. Hupeh, 1885-88, *Henry 2907* (GH); Prov. Kiangsi, Dagangshan, Fenyi City, 24 Aug 1985, *Yao 9193* (GH, NY); Prov. Sikang, 1935-36, *Wang 66442* (GH); Shanxi, Kolan Hsien, 31 Aug 1929, *Tang 173* (NY); Sichuan, Dujiangyan, E of Longxi, 6 Sep 1988, *Boufford & Bartholomew 24675* (MO, NY); Kweichow, Aug 1930, *Tsiang 6512* (NY), Nov 1930, *Tsiang 9542* (NY); Manchuria, Prov. Kininensis, 18 Jul 1896, *V. Komarov 219* (NY); Kwangtung Prov. Chong Uen Shan near Kau Fung, 2-30 Nov 1932, *Tsang 20665* (NY); Yunnan, *Ducloux 252* (NY);

Hong Kong, Lantao Island, Tungchung, Taishui-hang, 29 Sep 1940, *Taam 1819* (NY). **TAIWAN.** Niitagagun, Hosya, Kusunokizinzya, 14 Oct 1935, *S. Suzuki s.n.* (MO); Little Quemoy, 16 Sep 1961, *Chuang 4469* (GH); Botel Tobago, 16 Aug 1972, *Chang 7110* (NY). **JAPAN.** Hondo, Yamanakako in Kai, 3 Aug 1952, *K. Okamoto NSM 584* (BRIT, NY); Prov. Tootoomi, Pref. Shidzuoka, Hondo, 30 Sep 1959, *Miyoshi Furuse s.n.* (GH), 11 Oct 1960, *Miyoshi Furuse s.n.* (GH); Prov. Kadzusa, Pref. Chiba, Hondo, 5 Sep 1962, *Miyoshi Furuse s.n.* (GH); Prov. Yamashiro: Mt. Hieizan, Shirakawamichi, 9 Sep 1931, *Tagawa 617* (NY); Pref. Mie, Ogurusu, Kiwa-cho, Minamimuro-gun, 17 Nov 1977, *Mimoro, Tsugaru & Deguchi 4289* (MO); Pref. Settsu, Ashiya, 10 Sep 1954, *Hutoh 11517* (NY).

SOUTHEASTERN ASIA. VIETNAM. Tonkin, Chapa, *Petelot 6099* (NY). **THAILAND.** Phetchabun, Phu Miang, 2.10.1967, *Schimizu et al. T.11391* (NY); Chiang Mai, Doi Intanoid, 13 Sep 1974, *Larsen & Larsen 34512* (NY); Maehongson, Khun Yuam, 7 Sep 1974, *Larsen & Larsen 34254* (NY). **INDONESIA.** Lesser Sunda Islands, Flores, near Keli Moetoe, Kampong Ndoearia, 8-6-1938, *Jaag 1801* (GH); Java, Mt Gedeh, Tjibodas, 30 Apr 1950, *Kern 7998* (GH). **PHILIPPINES.** Northern Luzon, Prov. Benguet, Trinidad, 28 Sep 1904, *Williams 1972* (GH, NY).

AUSTRALIA. QUEENSLAND. Moreton District, Brisbane, 5 Aug 1937, *Blake 12965* (GH).

AFRICA. Eritrea. Ocule Cusai, 16 Sep 1902, *Pappi 1799* (NY).

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